AMENDMENTS TO THE CLAIMS

This listing of claims replaces all prior versions of claims in the application.

LISTING OF THE CLAIMS:

Claim 1 (Currently Amended): In quantum cipher communication using a light signal, a quantum cipher communication system characterized in that:

it uses a phase difference between a weak signal light which is so weak that a change in said weak signal light's ~~its~~ quantum mechanical state is detectable and an intense reference light for communicating a privacy key, wherein said phase difference is produced by a sender and a recipient adding a phase on said weak ~~the~~ signal light or said intense ~~the~~ reference light;

it has a ~~an optical balanced homodyne~~ detector which detects said phase difference as a difference signal of said ~~the~~ detector,

wherein said difference signal ~~phase difference~~ is assigned to bit 0 or bit 1 by comparing said difference signal with threshold values which are determined from a quantum-mechanical probability distribution of said difference signal ~~signals~~ obtained from a plurality ~~set~~ of said difference signal ~~phase differences~~ assigned bit 1 ~~0~~ or bit 0 ~~1~~; and

wherein an eavesdropping is detected by said ~~the~~ recipient measuring a change in said quantum-mechanical probability distribution of said difference signal, which is produced by the eavesdropping operation.

Claim 2-14 (Previously Deleted):

Claim 15 (Currently Amended): In quantum cipher communication using a light signal, a quantum cipher communication system as set forth in claim 1, which comprises a sender's apparatus, a recipient's apparatus and a transmission path connecting between said ~~the~~ sender's apparatus and said ~~the~~ recipient's apparatus, and is characterized in that

said ~~the~~ sender's apparatus comprises ~~of~~:

a light source for a laser beam;

a beam splitting means for splitting said laser beam into said weak ~~a~~ signal light and said intense ~~a~~ reference light;

a phase modulation means making ~~a phase change for every light which is~~ either of said weak signal light or said intense reference light a phase change for every light of said laser beam and

a light attenuation means for attenuating said weak signal light intensity,

said recipient's apparatus comprises ~~of~~:

a phase modulation means making ~~a phase change for every light which is~~ either of said weak signal light or said intense reference light a phase change for said every light transmitted from said ~~the~~ sender's apparatus through said ~~the~~ transmission path;

a superimposing means for superimposing said weak signal light and said intense reference light, either of which is phase changed by said phase modulation means of said ~~the~~ recipient's apparatus;

a pair of photoconductive diodes for converting two output lights from said superimposing means into respective electric signals; and

an amplifying means for amplifying a difference signal between said respective electric signals as said difference signal,

wherein said ~~the~~ sender, by using said phase modulation means of said sender's apparatus, imparts ~~for every light~~ either of said weak signal light or said intense reference light a phase change randomly selected from a set of phase changes predetermined by said ~~the~~ sender and said ~~the~~ recipient for said every light, and said ~~the~~ recipient, by using said phase modulation means of said recipient's apparatus, imparts either of said weak signal light or said intense reference light ~~for every light~~ a phase change randomly selected from said set of phase changes for said every light, as well as measures ~~for every light~~ said difference signal between said ~~the~~ electric signals amplified by said ~~the~~ amplifying means;

then, by using a public communication line, said ~~the~~ recipient notifies ~~to~~ said ~~the~~ sender of said phase changes imparted by said ~~the~~ recipient ~~for every light~~;

said ~~the~~ sender calculates a total phase difference between said weak signal light and said intense reference light by adding said ~~the~~ phase change made and notified by said ~~the~~ recipient and said ~~the~~ phase change made by said ~~the~~ sender ~~for every light~~, and notifies ~~to~~ said ~~the~~

recipient of each a ~~of the~~ light ~~lights~~ whose total phase difference satisfy a total phase condition predetermined by said ~~the~~ sender and said ~~the~~ recipient, as a raw key candidate for being adopted as a privacy key;

then said ~~the~~ recipient, for said each ~~every~~ light notified as said ~~a~~ raw key candidate, assigns bit 1 or bit 0 by comparing said difference signal thereof with said threshold values +X and -X, as assigning bit 1 when said difference signal thereof ~~measured~~ is equal or greater than said ~~a~~ threshold value +X, and assigning ~~assigns~~ bit 0 when said difference signal thereof ~~measured~~ is equal or less than said a threshold value - X, whereby said ~~the~~ recipient gets a privacy key;

said ~~the~~ sender, for said each ~~every~~ light notified as said ~~a~~ raw key candidate, assigns bit 1 or 0 according to a condition regarding said ~~the~~ total phase difference, which is predetermined by said ~~the~~ sender and said ~~the~~ recipient, whereby said ~~the~~ sender gets a privacy key;

wherein said threshold values +X and -X are determined from said quantum-mechanical probability distribution;

wherein said ~~an~~ eavesdropping is detected by said recipient measuring a change in a quantum-mechanical probability distribution; and

wherein said ~~the~~ sender and said ~~the~~ recipient can get a ~~the~~ privacy key in common with suitable effective detection efficiency and suitable error rate by selecting said threshold values +X and ~~or~~ -X.

Claim 16 (Currently Amended): In quantum cipher communication using a light signal, a quantum cipher communication system as set forth in claim15, characterized in that

said sender's apparatus further comprises ~~of~~:

~~a light source for a laser beam;~~

~~a beam splitter for splitting said laser beam into a signal light and a reference light;~~

a movable mirror as said phase modulation means of said sender's apparatus ~~making a phase change for every said signal light~~ ; and

a light attenuator ~~for~~ as said ~~attenuating said signal~~ light attenuation means ~~intensity~~,

a ~~the~~ transmission path comprising ~~comprises~~ a pair of paths for transmitting said weak signal light and said intense reference light respectively as said transmission path,

said recipient's apparatus further comprises ~~of~~:

a movable mirror as said phase modulation means of said recipient's apparatus ~~making a phase change for every said reference light transmitted from the sender's apparatus through one of the path of transmission~~;

a beam splitter ~~for~~ as said superimposing means ~~said signal light transmitted from the sender's apparatus through the other path of transmission and said reference light phase changed by said movable mirror of the recipient's apparatus;~~

~~a pair of photoconductive diodes for converting two output lights from said beam splitter into respective electric signals; and~~

~~a charge sensitive amplifier for amplifying a difference signal between said electric signals~~,

said set of phase changes are 0,90,180, and 270 degrees, and

said total phase condition is either 0 or 180 degrees.

Claim 17 (Currently Amended): In quantum cipher communication using a light signal, a quantum cipher communication system as set forth in claim15, characterized in that

said sender's apparatus further comprises ~~of~~:

a light source for a linearly polarized pulsed light as said light source;

a beam splitter for splitting said linearly polarized pulsed light into said weak ~~a~~ signal light and said intense ~~a~~ reference light as said beam splitting means;

a first long optical path comprising a half wave plate for rotating the polarization of said signal light by 90 degrees, a light attenuator for attenuating said weak signal light intensity as said light attenuating means, a phase modulator making ~~for changing the phase of~~ said weak signal light a phase change for every light of said linearly polarized pulsed light as said phase modulation means of said sender's apparatus, and mirrors; and

a first polarized beam splitter for returning said weak signal light transmitted through said first long optical path and said intense reference light onto a common optical axis, wherein said weak signal light and said intense reference light returned

to said ~~the~~ common optical axis have a mutual time delay based on the optical path length difference between said first long optical path for said weak ~~the~~ signal light and a first short optical path where said intense reference signal reaches to said ~~the~~ first polarized beam splitter from said ~~the~~ beam splitter, and have mutually orthogonal polarizations,

an ~~the~~ optical fiber comprising ~~comprises~~ a single mode optical fiber connected to said first polarized beam splitter, wherein said weak signal light and said intense reference light are transmitted there-through, ~~said single mode optical fiber~~ keeping said mutual time delay and said mutually orthogonal polarizations,

said recipient's apparatus further comprises ~~of~~:

a second polarized beam splitter for splitting said weak signal light and said intense reference light transmitted through said ~~the single mode~~ optical fiber;

a second long optical path comprising a half wave plate for rotating the polarization of said intense reference light transmitted through said optical fiber, and mirrors, and a second short optical path comprising a phase modulator ~~for~~ making said weak signal light a phase change for said every ~~signal~~ light transmitted through said optical ~~the single mode~~ fiber as said phase modulation means of said recipient's apparatus, wherein the time delay based on the optical path length difference between said second short optical path and said second long optical path of said ~~the~~

recipient's apparatus has the same absolute value and opposite sign to said mutual time delay in said ~~the~~ sender's apparatus;

a third polarized beam splitter for superimposing said weak signal light transmitted through said second short optical path and said intense reference light transmitted through said second long optical path as said superimposing means;

a pair of photoconductive diodes for converting two output lights from said third polarized beam splitter into respective electric signals as said pair of photodiodes; and

an amplifier for amplifying a difference signal between said respective electric signals as said amplifying means,

said set of phase changes are 0,90,180, and 270 degrees, and

said total phase condition is either 0 or 180 degrees.

Claim 18 (Currently Amended): A quantum cipher communication system as set forth in claim 17, characterized in that a third light polarizer is provided in an output side of said single mode optical fiber for making a correction for a disturbance of polarization of said intense reference light.

Claim 19 (Currently Amended): A quantum cipher communication system as set forth in any one of claims 15 to 17, characterized in that in addition to said ~~the~~ phase modulation

~~modulations designed~~ to transmit said privacy key ~~keys~~, ~~such~~ a phase modulation is ~~so~~ imparted ~~as~~ having a value later determined to make ~~for making~~ a correction for a fluctuation of the difference in optical path between said transmission path of said intense reference light and said transmission path of said weak signal light which develops by reason of an external cause.

Claim 20 (Currently Amended): A quantum cipher communication system as set forth in claim 19 ~~any one of claims 15 to17~~, characterized in that said phase modulation to transmit said privacy key ~~such phase modulations are so imparted as including those for transmitting privacy keys~~ and said phase modulation to make a correction for said fluctuation ~~those with values later determined~~ are randomly repeated.

Claim 21 (Currently Amended): A quantum cipher communication system as set forth in any one of claims 15 to17, characterized in that eavesdropping is detected on the basis of an increase in an ~~the~~ error rate of said difference signal.

Claim 22 (Currently Amended): A quantum cipher communication system as set forth in any one of claims 15 to17, characterized in that eavesdropping is detected on the basis of a change in a Wigner distribution function that indicates a quantum mechanical state of said weak ~~difference~~ signal light.

Claim 23 (Currently Amended): A quantum cipher communication system as set forth in any one of claims 15 to 17, characterized in that for said pair of ~~photoconductor~~ photoconductive diodes, use is made of silicon photoconductor diodes when said ~~the~~ light source has a wave length of 600 nm to 900 nm, and of InGaAs photoconductor diodes when said ~~the~~ light source has a wave length of 1000 nm to 1500 nm.

Claim 24 (Currently Amended): A quantum cipher communication system as set forth in any one of claims 15 to 17, characterized in that ~~the~~ said weak signal light has a typical intensity corresponding to as small as ~~a~~ single photon ~~or so~~, and said intense reference light has a typical intensity corresponding to photons as large as 10 millions in number.